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L19: Entry 2 of 2 File: USPT Feb 13, 2001

DOCUMENT-IDENTIFIER: US 6189102 B1
**** See image for Certificate of Correction ****
TITLE: Method for authentication of network devices in a data-over cable system

Brief Summary Text (2):
The present invention relates to communications in computer networks. More specifically, it relates to a method for authentication of network devices in a data-over-cable system.

Brief Summary Text (4):
Cable television networks such as those provided by Comcast Cable Communications, Inc., of Philadelphia, Pa., Cox Communications of Atlanta Ga., Tele-Communications, Inc., of Englewood Colorado, Time-Warner Cable, of Marietta Ga., Continental Cablevision, Inc., of Boston Mass., and others provide cable television services to a large number of subscribers over a large geographical area. The cable television networks typically are interconnected by cables such as coaxial cables or a Hybrid Fiber/Coaxial ("HFC") cable system which have data rates of about 10 Mega-bits-per-second ("Mbps") to 30+ Mbps.

Detailed Description Text (5):
Data-over-cable system 10 includes a Cable Modem Termination System ("CMTS") 12 connected to a cable television network 14, hereinafter cable network 14. FIG. 1 illustrates one CMTS 12. However, data-over-cable system 10 can include multiple CMTS 12. Cable network 14 includes cable television networks such as those provided by Comcast Cable Communications, Inc., of Philadelphia, Pa., Cox Communications, or Atlanta, Ga., Tele-Communications, Inc., of Englewood Colo., Time-Warner Cable, of Marietta, Ga., Continental Cablevision, Inc., of Boston, Mass., and others. Cable network 14 is connected to a Cable Modem ("CM") 16 with a downstream cable connection. CM 16 is any cable modem such as those provided by 3Com Corporation of Santa Clara, Calif., Motorola Corporation of Arlington Heights, Ill., Hewlett-Packard Co. of Palo Alto, Calif., Bay Networks of Santa Clara, Calif., Scientific-Atlanta, of Norcross, Ga. and others. FIG. 1 illustrates one CM 16. However, in a typical data-over-cable system, tens or hundreds of thousands of CM 16 are connected to CMTS 12.

Detailed Description Text (13):
Above RF interface 40 in a data-link layer 42 is a Medium Access Control ("MAC") layer 44. As is known in the art, MAC layer 44 controls access to a transmission medium via physical layer 38. For more information on MAC layer protocol 44 see IEEE 802.14 for cable modems. However, other MAC layer protocols 44 could also be used and the present invention is not limited to IEEE 802.14 MAC layer protocols (e.g., MCNS MAC layer protocols and others could also be used).

Detailed Description Text (17):
Above modem interface 48 in data link layer 42 is Point-to-Point Protocol ("PPP") layer 50, hereinafter PPP 50. As is known in the art, PPP is used to encapsulate network layer datagrams over a serial communications link. For more information on PPP see Internet Engineering Task Force ("IETF") Request for Comments ("RFC"), RFC-1661, RFC-1662 and RFC-1663 incorporated herein by reference. Information for IETF RFCs can be found on the World Wide Web at URLs "ds.internic.net" or "www.ietf.org."

Detailed Description Text (35):
When CM 16 has established an IP 54 link to TRAC 24, it begins "upstream" communications to CMTS 12 via DHCP layer 66 to complete a virtual data connection by

attempting to discover network host interfaces available on CMTS 12 (e.g., IP 54 host interfaces for a virtual IP 54 connection). The virtual data connection allows CM 16 to receive data from data network 28 via CMTS 12 and cable network 14, and send return data to data network 28 via TRAC 24 and PSTN 22. CM 16 obtains an address from a host interface (e.g., an IP 54 interface) available on CMTS 12 that can be used by data network 28 to send data to CM 16. However, CM 16 has only a downstream connection from CMTS 12 and has to obtain a connection address to data network 28 using an upstream connection to TRAC 24.

Detailed Description Text (38):
At step 94, a selection input is received on a first network device from the first network over the downstream connection. The selection input includes a first connection address allowing the first network device to communicate with the first network via upstream connection to the second network. At step 96, a first message of a first type for a first protocol is created on the first network device having the first connection address from the selection input in a first message field. The first message is used to request a network host interface address on the first network. The first connection address allows the first network device to have the first message with the first message type forwarded to network host interfaces available on the first network via the upstream connection to the second network.

Detailed Description Text (52):
The DHCP 66 addressing process shown in Table 5 was not originally intended to discover network host interfaces in data-over-cable system 10. CMTS 12 has DHCP 66 servers associated with network host interfaces (e.g., IP interfaces), but CM 16 only has as downstream connection from CMTS 12. CM 16 has an upstream connection to TRAC 24, which has a DHCP 66 layer. However, TRAC 24 does not have DHCP 66 servers, or direct access to network host interfaces on-CMTS 12. FIGS. 7A and 7B are a flow diagram illustrating a method 140 for discovering network host interfaces in data-over-cable system 10. When CM 16 has established an IP 54 link to TRAC 24, it begins communications with CMTS 12 via DHCP 66 to complete a virtual IP 54 connection with data network 28. However, to discover what IP 54 host interfaces might be available on CMTS 12, CM 16 has to communicate with CMTS 12 via PSTN 22 and TRAC 24 since CM 16 only has a "downstream" cable channel from CMTS 12.

Detailed Description Text (138):
After a Domain Name System identifier is obtained from the Domain Name System table (e.g., Table 11), the Domain Name System identifier obtained from the table is used in the test at step 400 (FIG. 21B) to compare with the second Domain Name System identifier from the registration message. In one embodiment of the present invention, the IP 54 address associated with the Domain Name System identifier obtained from the Domain Name System table (e.g., Table 11) can also be used to verify IP 54 addresses allegedly for CPE 18. In such an embodiment, the second IP 54 address from the registration message for CPE 18 is compared to the first IP 54 address for CPE 18 stored in the Domain Name System table (e.g., Table 11) during the reverse Domain Name System lookup. Such an embodiment can be used to simplify the test at step 402. However, IP 54 address lookup for CPE 18 can also be done with an Address Resolution Protocol table at step 302 using the DNS table (e.g., Table 11).

Current US Cross Reference Classification (1):
709/201

Current US Cross Reference Classification (2):
709/223

Current US Cross Reference Classification (3):
709/230

Current US Cross Reference Classification (4):
709/245

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L19: Entry 1 of 2 File: USPT Aug 7, 2001

DOCUMENT-IDENTIFIER: US 6272150 B1
**** See image for Certificate of Correction ****
TITLE: Cable modem map display for network management of a cable data delivery system

Brief Summary Text (5):
Cable television transmission systems have been utilized since the 1980's for the transmission of data, point-to-point or point-to-multipoint at T1 carrier rates of 1.544 megabits per second in a cable television system environment. Scientific-Atlanta, Inc. introduced and marketed a product known as the Model 6404 Broadband Data Modem in the early 1980's. One user coupled to a cable television distribution network can communicate to the world or two users, coupled to the cable television distribution network having a 0-54 Megahertz upstream or reverse path and a typical downstream path at frequencies above this range, can communicate with each other or with the world via a telephone central office. The upstream and downstream channels are spaced at approximately 750 kHz spacing; the modulation scheme is quadrature amplitude modulation, for example, 16-QAM. Each of two parties coupled to the cable television network can communicate in real time in a full duplex manner with each other, each having an upstream and a downstream radio frequency path. A Model 6440 frequency translator translates the upstream channel path frequency to the downstream channel path frequency for each party as necessary. Up to 24 voice or data telecommunications channels are provided by such equipment. As is known in the data communication arts, such channels can be grouped to provide digital data services at variable data rates, for example, 64 kbits/sec, 256 kbits/sec or even 1.544 mbits/ sec.

Brief Summary Text (8):
U.S. Pat. Nos. 5,347,304 and 5,586,121 describe an asymmetric network in which one path to a computer or work station is via a cable network such as a cable television network and the other path is via the telecommunications network. The '121 patent describes a network manager which handles or controls the forward (downstream) and return (upstream) communication to establish interactive full-duplex real-time network sessions between a host and a selected client device. Connection to the network is managed based on parameters such as the amount of times a device's channel requests have gone unfulfilled. The upstream channels are assessed as to quality based upon error rates, noise floor and signal-to-noise ratio. Channel quality monitoring for errors and signal-to-noise ratio is done transparently to the user and the applications. A failure in periodic upstream "heartbeat" messages at selected time intervals can indicate an upstream channel failure and necessitate a channel reassignment.

Detailed Description Text (24):
The depicted cable data delivery system supports either connection-less or connection-oriented communication paradigms. As a system develops, the system can be expanded to support additional services including, for example, variable bit rate (VBR) and available bit rate (ABR) services, for example, based on the ATM class of service architecture described by Koperda et al., U.S. application Ser. No. 08/627,062, filed Apr. 3, 1996, Ser. No. 08/738,668, filed Oct. 16, 1996 and Ser. No. 08/818,037, filed Mar. 14, 1997. As will be described further below, Internet protocol (IP) is used in the cable data delivery system as the network level communications protocol. Internet protocol addressing is described further in copending U.S. Patent Applications already cited above bearing Ser. Nos. 08/833,198, 08/837,073, 08/843,061 (now U.S. Pat. No. 6,208,656), Ser. No. 08/843,056 (now U.S. Pat. No. 6,178,455), Ser. No. 08/838,833, 08/832,714, and Ser. No. 08/840,304, filed concurrently herewith.

Detailed Description Text (25):
The headend equipment 122 that is provided by one or more service providers is represented by router 101 for routing cable data, communications manager 102 for organizing and forwarding cable data in the downstream direction over radio frequency facilities, a telephone modem pool 135 for receiving cable data in the upstream path over telecommunications facilities and a network control and management computer/server 111, 125 for diagnostic, billing, provisioning and other functions necessary to network management and control. The slower speed upstream path 131 may be wired or wireless (for example, by cellular telephone) and, if wireless, may be provided by non-telephone low earth orbit satellite or telephone satellite path. Router 101 is connected to Internet 150 by wide area network (WAN) 124. Router 101 is further coupled to modem pool 135 and to control and management server 111, 125 by 10BaseT Ethernet local area network (LAN) 128.

Detailed Description Text (26):
Network control and management server 111 is preferably a computer or work station having a processor, memory and an operator display. In one embodiment of the control and management server 111, the management platform is OpenView (OV) Network Node Manager software available from Hewlett Packard Corporation. The OV platform provides facilities for transport of simple network management protocol (SNMP) requests to software agents resident in network components including the cable modem, the communications manager and the modem pool as will be further discussed in reference to FIGS. 6 and 7. The control and management server provides data/timestamp to data stored and received from components and automatically determines severity levels by comparison of data to predetermined thresholds.

Detailed Description Text (29):
The network control and management server 111 communicates with the communications manager 102(as well as the modem pool 135) via Ethernet LAN 128. The internal processor of the communications manager in accordance with what will be referred to herein as agent software communicates with a hierarchy of management information bases (MIB's) or memory storage locations to retrieve identified data stored in the MIB's as will be discussed in further detail in reference to FIG. 7. Network control and management server 125 collects statistics from the modem pool 135 in a similar manner.

Detailed Description Text (35):
Router 101, such as a Cisco Systems 7000 series router, is a gateway between the Internet 150 and the cable data delivery system. Standard wide area facilities, such as T-1 or T-3 carrier telephone facilities, connect the router 101 to the Internet. In the downstream direction from the router toward subscriber location 175, 100 Nbps Fast Ethernet (100 Base T) local area network 128 is used to interconnect the router with the communications manager 102. End-to-end networking is provided using Internet protocol.

Detailed Description Text (37):
Packets from Internet 150 that contain the IP address of a host 108(i) are received in CATV head end 122, are put in the proper form for transmittal over cable 132 belonging to the CATV system, and are transmitted via cable 132 to RF modem 106(j) of modems 106(a) to 106(n) to which destination host 108(i) of hosts 108(a) to 108(n) is attached. RF modem 106(j) reads the IP address of host 108 from the packet and routes the packet to host 108(i). Packets from host 108(i) which are intended for a destination in Internet 150 go to RF modem 106(j), which routes them via telephone line 131 and public switched telephone network (PSTN) 109 to a telephone modem (Tmodem) 110(k) in telephone modem pool 135 in head end 122. Tmodem 110(k) routes the packet to router 101, which routes it to Internet 150. Since public switched telephone network 109 allows bidirectional communication, router 101 may also route packets received from Internet 150 for host 108(i) to host 108(i) via Tmodem 110(k) of Tmodems 110(a) to 110(n) and RF modem 106(j). As will be explained in more detail in the following, this route is used in the event of a failure in the CATV portion of network 100 including, for example, but not limited to network elements 103, 104, 105, 132.

Detailed Description Text (41):

When packets are to go to a host 108 via cable 132, they are routed to communications manager 102, which puts the packets into the proper form for transport by that link-level network.

Detailed Description Text (43):
FIG. 4 shows how data is transported on cable 132 in a preferred embodiment. Cable 132 is an RF medium 401 which carries data in a fixed number of channels 403 (0-m). Each channel 403 occupies a portion of the range of frequencies transported by cable 132. Within a channel 403(i), data moves in superframes 405. Each superframe 405 contains a superframe header (SFHDR) 414 and a fixed number of fixed-sized superpackets 407 (1-n). The only portion of the superframe header 414 that is important to the present discussion is stream identifier (STRID) 415, which is a unique identifier for the stream of data carried on channel 403. The combination of a channel's frequency and the stream identifier 415 uniquely identifies the network to which cable 132 belongs in the CATV system. As will be explained in more detail later, this unique identification of the network cable 132 belongs to is used by communications manager 102 to determine which network should receive the IP packets intended for hosts 108 connected to a given RF modem 106(i).

Detailed Description Text (45):
Returning to communications manager 102, that component receives IP packets 301 addressed to hosts 108 connected to networks whose link layers are cables 132 connected to head end 105 and routes them to the proper RF modems 106 for the hosts. It does this using a routing table which relates the IP address of an active host 108 to one of the networks and within the network to a <channel, pipe, Link ID> triple specifying the RF modem 106 to which the host 108 is connected. As employed in the present context, an active host is one that currently has an IP address assigned to it. Using the information in the routing table, communications manager 102 makes superframes 405 for each channel 403(i) in the network containing cable 132. The superframes contain superpackets 407 directed to the RF modems 106 connected to that channel for which communications manager 102 has received IP packets 301. The superframes are stored in a dual-ported memory which is accessible to QPR modulators 103.

Detailed Description Text (60):
Comparison of addresses for routing purposes is done using subnetwork masks 608. The order in which an IP address being routed is compared to addresses in the routing table is by the unmasked length of the address in the routing table. Thus, the address being routed is compared first with addresses that are completely unmasked. For details, see Stevens, supra, pp. 7-9 and 140-141.

Detailed Description Text (63):
IP network B 208(i) may be one of several such networks, each of which will have its own statically-assigned NetID 605. Network B 208(i) has as its link layer one or more cables 132, to which RF modems 106 are connected. The router for network B 208(i) is communications manager 102. Each active RF modem 206(j) in network B 208(i) has a set 210(j) of IP addresses having network B 208(i)'s network ID 605 that are available to be assigned to hosts 108 connected to RF modem 206(j). An active RF modem 106 is one that has an active host 108 connected to it. Any IP address having the network ID for the network may belong to a given set 210(j). The link level network for each set of IP addresses 210(j) is the LAN 133 connecting the hosts 108 with RF modem 106(j). RF modem 106(j) serves as the router for that set of addresses. IP addresses of hosts 108 in net B 208(i) are dynamically assigned by control/management server 111, 125. When RF modem 106(j) becomes active, control/management server 111, 125 assigns modem 106(j) a set of IP addresses for the hosts 108 connected to RF modem 106(j). The IP addresses have the NetID 605 for network B 208(i)and as many host IDs 613 as are required for the hosts 108. Every host 108 connected to an RF modem 106(j) has an IP address for RF modem 106(j). Cable data network 100 conserves IP addresses by giving every RF modem 106(j) on a network the same IP address on LAN 133 connecting hosts 108 to RF modem 106.

Detailed Description Text (65):
Router 101 normally routes IP packets destined for network B to communications manager 102 and those destined for network D to modem pool 135. If there is a failure in network B, router 101 can also route packets destined for a host 108

connected to RF modem 106(j) to RF modem 106(j) via network D.

Detailed Description Text (66):
FIG. 2A also shows the IP and link layer addresses by means of which the components of CDN 100 may be reached. Beginning with the components on Net A 206, router 101 has an IP address 203(b) of its own in Net A 206 and also has an address 205(a) on LAN 120 and an address 207 on WAN 124. Communications manager 102 has an IP address 203(c) of its own in Net A 206 and an address 205(d) on LAN 120. Router 101 also routes all packets to communications manager 102 that are to be carried via the networks B 208 specified in one or more NETID fields 605 in the IP addresses. Continuing with control/management server 125, that component has an IP address 203(e) in Net A 206 and a LAN address 205(b). Modem pool 135 has an IP address 214(b) in Net D 212, a LAN address 205(c), and a telephone number 208(a) in PSTN 109.

Detailed Description Text (111):
Once added to the modem map, the modem's status is tracked by the network management system and the cable modem's state values are propagated to the higher level maps and icons in the topology. Cable modems are optionally labeled with data related to the modem such as subscriber folio number, modem MAC address, subscribers home address and such other information as the network operator deems important.

Current US Cross Reference Classification (2):
709/217

CLAIMS:

15. The apparatus of claim 5, wherein the modem status collection agent obtains the operational status of each modem in said network by receiving at least one trap message communicated using a simple network management protocol (SNMP).

30. The method of claim 20, wherein the modem status collection agent obtains the operational status of each modem in said network by receiving at least one trap message communicated using a simple network management protocol (SNMP).

Set Name side by side	**Query**	**Hit Count**	**Set Name** result set
	DB=USPT; PLUR=YES; OP=ADJ		
L19	L18 and (compar$ with IP with address$)	2	L19
L18	L16 and L2	32	L18
L17	L16 and L11	0	L17
L16	L1 and ((cable adj1 modem) with MAC)	34	L16
L15	L14 and L11	0	L15
L14	L1 and ((cable adj1 modem) and MAC).ab.	1	L14
L13	L12 and (compar$ with address with protocol with layer$)	0	L13
L12	L11 and (lan or internet or intranet).ab.	40	L12
L11	L1 and (communicat$ with between with networks).ab.	482	L11
L10	L7 or L6	3	L10
L9	L7 or L6	3	L9
L8	L7 or L6	3	L8
L7	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L7
L6	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L6
L5	L1 and (communicat$ with between with internet with (intranet or lan))	158	L5
L4	L1 and (communicat$ with between with (internet or intranet) with lan)	76	L4
L3	L1 and (communicat$ with between with networks)	4896	L3
L2	L1 and (communicat$ with networks)	10944	L2
L1	((709/$)!.CCLS.)	17420	L1

END OF SEARCH HISTORY

Set Name side by side	**Query**	**Hit Count**	**Set Name** result set
	DB=USPT; PLUR=YES; OP=ADJ		
L18	L16 and L2	32	L18
L17	L16 and L11	0	L17
L16	L1 and ((cable adj1 modem) with MAC)	34	L16
L15	L14 and L11	0	L15
L14	L1 and ((cable adj1 modem) and MAC).ab.	1	L14
L13	L12 and (compar$ with address with protocol with layer$)	0	L13
L12	L11 and (lan or internet or intranet).ab.	40	L12
L11	L1 and (communicat$ with between with networks).ab.	482	L11
L10	L7 or L6	3	L10
L9	L7 or L6	3	L9
L8	L7 or L6	3	L8
L7	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L7
L6	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L6
L5	L1 and (communicat$ with between with internet with (intranet or lan))	158	L5
L4	L1 and (communicat$ with between with (internet or intranet) with lan)	76	L4
L3	L1 and (communicat$ with between with networks)	4896	L3
L2	L1 and (communicat$ with networks)	10944	L2
L1	((709/$)!.CCLS.)	17420	L1

END OF SEARCH HISTORY

Set Name side by side	**Query**	**Hit Count**	**Set Name** result set
	DB=USPT; PLUR=YES; OP=ADJ		
L13	L12 and (compar$ with address with protocol with layer$)	0	L13
L12	L11 and (lan or internet or intranet).ab.	40	L12
L11	L1 and (communicat$ with between with networks).ab.	482	L11
L10	L7 or L6	3	L10
L9	L7 or L6	3	L9
L8	L7 or L6	3	L8
L7	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L7
L6	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L6
L5	L1 and (communicat$ with between with internet with (intranet or lan))	158	L5
L4	L1 and (communicat$ with between with (internet or intranet) with lan)	76	L4
L3	L1 and (communicat$ with between with networks)	4896	L3
L2	L1 and (communicat$ with networks)	10944	L2
L1	((709/$)!.CCLS.)	17420	L1

END OF SEARCH HISTORY

Cable modem

MAC

Set Name side by side	**Query**	**Hit Count**	**Set Name** result set
	DB=USPT; PLUR=YES; OP=ADJ		
L12	L11 and (lan or internet or intranet).ab.	40	L12
L11	L1 and (communicat$ with between with networks).ab.	482	L11
L10	L7 or L6	3	L10
L9	L7 or L6	3	L9
L8	L7 or L6	3	L8
L7	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L7
L6	L1 and (communicat$ with between with internet with (intranet or lan)).ab.	3	L6
L5	L1 and (communicat$ with between with internet with (intranet or lan))	158	L5
L4	L1 and (communicat$ with between with (internet or intranet) with lan)	76	L4
L3	L1 and (communicat$ with between with networks)	4896	L3
L2	L1 and (communicat$ with networks)	10944	L2
L1	((709/$)!.CCLS.)	17420	L1

END OF SEARCH HISTORY